







Q15 #2104e

## Deloro Mine Site Rehabilitation

The Deloro Mine Site, Deloro, Ontario is located on the Moira River in Hastings County approximately 8 km east of Marmora. Situated where the Canadian Shield intersects the Great Lakes Lowlands, the area is rich in mineral deposits. Arsenic and other materials have been leaching into the Moira River and have contaminated the Moira River basin. Arsenic in the environment is a potential health hazard. Environment Ontario has been operating an arsenic treatment plant at the site since April 1979.

Deloro from the Spanish 'del oro', "of gold", grew out of the gold rush days and became known as the "Valley of Gold". Mining and refining at the Deloro Mine Site started in the 1860s and continued until 1961. Historical records show that gold was discovered at nearby Eldorado in 1866 and at Deloro some time prior to 1871. Several mining operations extracted gold-bearing ore in the early years. By 1871 approximately 25 shallow shafts had been sunk at the Deloro site. The high arsenic content of the ores made the recovery of gold difficult and hazardous, but a series of significant technical developments in mineral processing made it possible. Mine exploration at the site continued and the still viable Gatling, Tuttle and Red shafts were deepened and extended.

### Mines Closed: Smelting Continued

The gold mines closed in the early 1900s and the site with its smelter was used to process arsenic-bearing silver and cobalt ores from the Northern Ontario mines in Cobalt and GowGanda. The production and marketing of arsenical pesticides, from arsenic as a by-product of the smelting operations, continued as a

main activity at the site until the market gave way to organic pesticides in the late 1950s.

Deloro was the first plant in the world to produce cobalt commercially.

Deloro was also a leading producer of stellite, a cobalt-chromium-tungsten alloy which was resistant to heat, wear, abrasion and corrosion; and which had considerable strategic value during the war years. During the life of the smelting operations, ores from all over the world, including Northern Rhodesia, Morocco and the Belgian Congo were processed at Deloro.

In the 1930s, 1940s and 1950s smelted ore, or speiss, from Eldorado Nuclear Limited in Port Hope were brought to Deloro for further refinement. Materials smelted and refined at Deloro included: gold, silver, arsenic, cobalt, nickel, lead, bismuth and copper.

### A Century of Work Leaves Hazardous Materials

Large quantities of refining slag, mine tailings, laboratory wastes, arsenic compounds and arsenical pesticides remained at the site. A century of the handling of hazardous materials and chemicals has left the site with massive contamination problems. Fuels, chemicals and raw materials such as sulphuric acid, coke,

lime, soda ash, caustic soda, liquid chlorine, salt, scrap iron, sodium chlorate and fuel oil were handled and deposited at the site. The radioactive material brought in from Eldorado Nuclear resulted in radioactive slag material which over time was present on much of the site.

### **Monitoring and Abatement Begins**

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In the early 1960s the Ontario Government, began monitoring arsenic levels in the Moira River and abatement activities began. In 1978 the site owner, Erickson Construction Company Limited, was ordered under the Environmental Protection Act to take specific measures to control arsenic discharges to the Moira River.

A Stop Order was issued in 1979 against the Company. Non-compliance with the Orders issued, combined with the declaration by the Company of a lack of operating funds resulted in the MOE taking over control of the site in the same year and with it the operation of the existing arsenic treatment facility. To date the MOE has spent approximately \$6.5 million for site clean-up activities and for the treatment of arsenic contaminated surface and groundwater.

In July 1992, the Ontario drinking water standard for arsenic was reduced by 50 per cent to 0.025 mg/L from 0.050 mg/L.

### **New Plant Treats Arsenic**

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In 1982 MOE renovated the former research laboratory building and constructed a new "state of the art" arsenic treatment plant. The plant was put into service in January 1983. The present collection, storage and treatment system consists of an 80 m long concrete cut-off dike along the Moira River in the vicinity of the former arsenic baghouse, six pumping stations one of which pumps directly from the Tuttle Shaft, a 9084 m<sup>3</sup> clay-lined equalization storage basin, a 50 m by 40 m underdrained sludge drying lagoon and the arsenic treatment and removal system.

### **How it Works**

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The arsenic treatment system operates as follows:

Groundwater, including groundwater and surface water diverted by the concrete cut-off dike in the vicinity of the former arsenic baghouse, is pumped from the six pumping stations to the equalization storage basin. Arsenic concentrations which may range from 50 mg/L to 1500 mg/L are equalized in the storage basin for more efficient treatment. At the treatment plant, ferric chloride is added in the first mixing tank at the ratio of 2.5 parts iron to 1.0 part arsenic. The mixture flows from this tank to a second

tank where lime is added. The lime brings the pH level of the water up to 9.2 and ferric arsenate, a fine, brownish precipitate begins to form. The mixture then flows to a third tank where a polymer flocculant, which is a substance of high molecular weight, is added to help the ferric arsenate form larger particles. The large particles, which settle out quickly in the clarifier as a brownish, ferric arsenate sludge, are pumped from the bottom of the upflow clarifier to the sludge drying lagoon. Leachate from the sludge drying lagoon is pumped back to the equalization storage basin for re-processing. The treated effluent with 99.5 to 99.9 per cent of the arsenic removed is returned to the Moira River.

In 1987, 8 ha of ferric hydroxide tailings (red mud) on the east side of the Moira River were covered with 0.5 m of crushed limestone to prevent wind erosion and particulate matter carry-over, to elevate the pH of the tailings and to stabilize the containment dams.

### **More Remedial Measures Taken**

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Other remedial measures undertaken at the site since 1979 include:

- the demolition of unsafe structures;
- the remediation of specific contamination sources such as the pesticides building and the arsenic baghouse;
- the removal of waste oil and pesticides;
- and the erection of fencing around open mine shafts and workings.

A number of studies and investigations have been undertaken to assess the health, safety and environmental problems at the site. The latest report in 1990 addressed the rehabilitation and clean-up of the smelting and refining plant site on the west side of the Moira River.

#### **River Monitored Hourly, Daily and Weekly**

The MOE has an extensive site monitoring program for arsenic and heavy metals. In general, the current monitoring program consists of daily monitoring of the plant influent and effluent; weekly monitoring of eight stations along the Moira River and seven stations related to the tailings area; monthly monitoring of the six pumping stations; and quarterly monitoring of 45 groundwater monitoring wells. An automatic sampler on the Moira River at Highway #7 takes hourly samples 24 hours a day, everyday. The arsenic concentrations from the daily composite samples are used in conjunction with the stream flow data to calculate the average daily arsenic loadings to the Moira River.

#### **Arsenic Concentrations and Loadings Substantially Reduced**

The attached graph, "Arsenic Concentrations in Moira River @ Hwy #7, 1979 to 1992", shows that arsenic concentrations in the Moira River have been substantially reduced; however, the treatment objectives of 0.05 mg/L as an annual average arsenic concentration and 0.2 mg/L as a maximum arsenic concentration at any time continue to be exceeded during periods of low flow. In 1979 the average annual arsenic concentration was 0.33 mg/L compared to 0.12 mg/L in 1991 and 0.02 mg/L in 1986 which is the year with the lowest concentration. The graph shows average monthly concentrations.

As illustrated by the second graph, "Arsenic Loadings in Moira River @ Hwy #7, 1979 to 1992", arsenic loadings have also been substantially reduced. The average daily arsenic loading in 1979 was 52.1 kg/d compared to 4.2 kg/d in 1991 which is the year with the lowest loading. The values shown are average monthly loadings.

The last graph, "Flow in Moira River @ Hwy #7, 1979 to 1992", shows the flow in the Moira River in m<sup>3</sup>/s. The values represent average monthly flows.

#### **New Funding/Studies for Further Cleanup**

In March 1992, an agreement was signed with Environment Canada approving the Deloro site for funding under the National Contaminated Sites Remediation Program (NCSRP). The NCSRP, which was established to address high-risk contaminated sites, is a 50/50 cost sharing program for the period April 1, 1990 to March 31, 1995.

In July 1992, work began on an in-depth review of the mine hazards at the site. This includes research, review and collection of historical data which will be used to locate, identify and secure the collapsing mine workings. A survey to pinpoint the location of all mine workings began in September 1992.

The operation of the arsenic treatment plant and the monitoring of the Moira River and the site continues.

The MOE has finalized a multi-phased, multi-year rehabilitation plan for the site to address potential health, safety and environmental problems. This includes upgrades to the arsenic treatment plant, safe closure of the mines on the east and west side of the Moira River, stabilization of the red mud tailings area, securement of site wastes, and the demolition/removal of the infrastructure associated with the smelting and refining plant site on the west side of the Moira River.

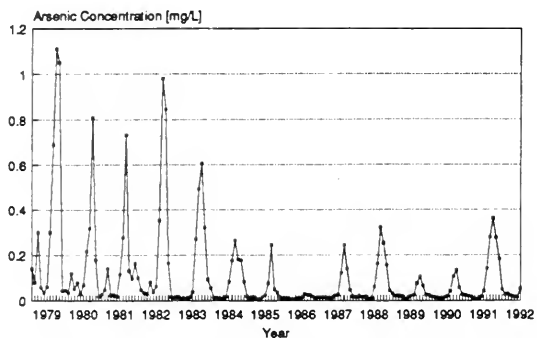
Funding strategies for the implementation of the rehabilitation plan are now being finalized. In the interim, work is proceeding on the priority items of the plan subject to the availability of funds.

For more information, contact:

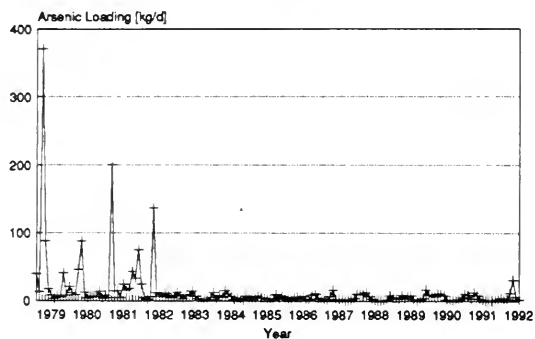
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ARSENIC CONCENTRATIONS IN MOIRA RIVER  
@ HWY # 7  
1979 TO 1992



ARSENIC LOADINGS IN MOIRA RIVER  
@ HWY # 7  
1979 TO 1992



FLOW IN MOIRA RIVER  
@ HWY # 7  
1979 TO 1992

